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Diabatic forcing in fully compressible model II

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1 Introduction

The aim of this stay was to continue in investigation of diabatic forcing in fully compressible ALADIN model. Former 2D experiments indicated that solutions using hydrostatic adjustment parameterization and exact treatment of the diabatic terms converge after very short period, for more details see Trojakova (2003), thus next effort were put on the study in three dimensions.

2 What have been done

An available time was spend on following items:

- phasing modification to cycle CY28t0
- debugging of the tool for postprocesing 3D academic files (ACADPOS)
- 3D academic test with the artificial source of heating

3 3D academic case

In academic frame work the 3D experiments were performed. An symmetric smooth artificial source of heating was introduced and otherwise no model "physic" was allowed.

The physical tendency, $\frac{\partial T}{\partial t}\big|_{phys}$ usually computed by physical parameterization, was defined as smooth symmetric function f.

$$f(X) = \begin{cases} 0, & X > R \\ cos^2(\frac{\pi r}{2R}), & X \leq R \end{cases}$$

where R is radius of source, $X[x, y, z]$ determines the position with coordinates $[x, y, z]$, $X_c[x_c, y_c, z_c]$ is middle point of source and $r^2 = (x - x_c)^2 + (y - y_c)^2 + (z - z_c)^2$.

In the equation for evolution of temperature T (1) and pressure (2) where as pressure variable $\hat{q} = ln\frac{p}{\pi}$ was used

$$T_1 = T_1 + \Delta t. \left.\frac{\partial T}{\partial t}\right|_{phys} \tag{1}$$

$$\hat{q}_1 = \hat{q}_1 + \Delta t. \left.\frac{\partial \hat{q}}{\partial t}\right|_{phys} \tag{2}$$

following artificial tendencies were used in case hydrostatic adjustment parameterization:

$$\left.\frac{\partial T}{\partial t}\right|_{phys} = \frac{Q}{c_{pd}} f \tag{3}$$

$$\left.\frac{\partial \hat{q}}{\partial t}\right|_{phys} = 0 \tag{4}$$

and exact treatment of diabatic terms:

$$\left.\frac{\partial T}{\partial t}\right|_{phys} = \frac{Q}{c_{vd}} f \tag{5}$$

$$\left.\frac{\partial \hat{q}}{\partial t}\right|_{phys} = \frac{Q}{T c_{vd}} f \tag{6}$$

where c_{vd} is specific heat of dry air at constant volume and c_{pd} is specific heat of dry air at constant pressure. The settings of the 3D experiment is following:

- biperiodic NDGL=NDGUX=NDLON=NDLUX=144 & NBZONL=NBZONG=0
- quadratic grid NSMAX=NMSMAX=47

- isothermal $T_0 = 273$ K
- at rest $V_0 = 0$ m/s
- horizontal resolution 100 m
- vertical resolution 100 m
- 100 vertical levels
- $p_0 = 101325$ Pa

used scheme

- 2TL SL-SI scheme
- TSTEP = 2 s
- SITR=330 K, SITRA=210 K, SIPR=101325 Pa
- NPDVAR=2, NVDVAR=3
- NSITER=0
- HDIR⋆ = 0
- LPC⋆ = false

The heating was acting just in one time-step (NSTEP=3) with maximum $\delta T \doteq 0.1$ K. Figures 1. - 48. present horizontal cross-sections of perturbations of temperature, components of wind and vertical velocities in the middle of the diabatic source and the domain. Abbreviation "approx" denotes use of the hydrostatic adjustment parameterization and "exact" stands for exact treatment of diabatism.

4 Conclusion

The simple academic 3D experiment confirm the results obtained in 2D. Similarly after short time the solutions differencies are negligible. The 2D and 3D simulation are consistent in modeled features. Further investigation should be aimed into real 3D case study to verify behavior and stability of exact treatment of diabatic terms in the real conditions.

5 Source code modification

All the modifications were done on cycle CY28t0main. For running experiments with 100 levels and vertical resolution 1000 m was necessary modify parameter NRLEVX=4000000 in arp/setup/sudim1.F90.

5.1 Modification concerning an artificial source of heating

arp/namelist/namsource.h
arp/module/yomsource.F90
ald/control/su0yoma.F90
ald/control/susource.F90
arp/adiab/cpg.F90
arp/phys_dmn/mf_phys.F90
ald/adiab/cpsource.F90

5.2 Wind too strong and LADVF

BEWARE: In 3D academic experiments you have to use **LADVF=.FALSE.** even for 2TL scheme, otherwise you can spend quite long time in looking for why there is "Wind too strong!" abort in zero wind condition. To allow LADVF=.FALSE. for 2TL scheme you should put in comments calling aborts in ./arp/setup/sudyn.F90.

An executable, scripts, namelist, input files, sources are stored on delage /cnrm2_a/mrpe/mrpe694/2004/M3D.diabatism.tar

References

Alena Trojáková, 2003: Diabatic forcing in fully compressible model *report from stay*